Chapter 7
Tropical Cyclone Support Summary

7.1 INTRODUCTION

This chapter of the 1998 Annual Tropical Cyclone Report is provided to inform the reader on some of the support that is provided to JTWC. This summary is by no means the total support provided to this organization, but reflects the major ongoing efforts.

7.2 SYSTEMATIC APPROACH TO TROPICAL CYCLONE FORESACTING

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The Systematic Approach to Tropical Cyclone Track Forecasting (Systematic Approach) is a project initiated in 1994 to assist forecasters in making optimum use of available numerical models and other objective techniques when formulating the official track forecast. During the last year, a preliminary Model Traits Knowledge Base has been developed based on the detailed analysis of all highly erroneous NOGAPS and GFDN track forecasts of western North Pacific TCs during 1997. Key features of this knowledge base are: (i) the identification four error mechanisms that frequently degrade NOGAPS forecasts only, one error mechanism that frequently degrades GFDN forecasts only, and two error mechanisms that frequently degrade NOGAPS and GFDN forecasts simultaneously; (ii) identification of key indicators in the numerical model forecast fields for each of the frequently recurring error mechanisms; and (iii) thorough documentation of each frequently recurring error mechanism that includes illustrative case studies. With this knowledge base, the forecaster can identify model track forecasts that may be highly degraded, and which should either be excluded or given low weight when formulating the official track forecast.

Research was also conducted into applying ensemble prediction concepts to formulate a selective consensus from the subset of numerical model tracks to be identified by the forecaster via the Model Traits Knowledge Base described above. This research extends that of J. Goerss (Naval Research Laboratory- Monterey), who has developed a simple, economical (free) consensus of up to three global model or two regional model forecast tracks, by using all five numerical model tracks normally available to JTWC. This extension of the Goerss technique will provide a tool to assist the forecaster in comparing the model tracks and assessing whether a particular track is good, and thus should be included in the consensus, or degraded and thus should be discarded. Features of the ensemble approach that are useful to the forecaster include cluster recognition, cluster membership analysis, and determination of the overall spread of the ensemble.

Development has continued on a Systematic Approach Expert System (SAES) prototype that is to undergo a preliminary field evaluation during the 1999 western North Pacific season. The SAES employs sophisticated field and forecast track displays, and incorporates key aspects of the Model Traits Knowledge Base and ensemble analysis concepts described above. Key features of the SAES include: a systematic logic for presenting information that a forecaster needs to evaluate the present synoptic situation to assess the likely quality of the dynamical or other objective guidance, a computation of the consensus track of selected numerical models, and a recording of the forecaster's prognostic reasoning for accepting or rejecting certain numerical model forecasts that can be used as guidance by the next forecaster.

7.3 TROPICAL CYCLONE SUPPORT SUMMARY FOR ATCF

The Automated Tropical Cyclone Forecasting System Version 3.3 C. R. Sampson, A. J. Schrader, M. D. Frost, and D. H. Grant Naval Research Laboratory, Monterey, CA 93943

The UNIX version of the Automated Tropical Cyclone Forecasting System (ATCF) has been used successfully at JTWC since 1996. This year, system support was extensive and included moving all ATCF related equipment out of Guam and into the new JTWC at NPMOC Pearl Harbor and the new AJTWC at NPMOC Yokosuka. This was done in addition to developing a new version of ATCF. ATCF 3.3 was installed at JTWC for the 1999 season and includes the following improvements:

1) A Y2K compliant database and software, 2) Extended forecast periods that include 96- and 120-hours, 3) Scatterometer and cloud tracked wind display, 4) Toggles switches for land fill and geographic labels, 5) Edit templates for fix and track data, 6) Automated recall of previously saved window states, 7) A new Tactical Environmental Data Server (TEDS) - Version4.x, 8) A NOGAPS vortex tracker (NGPR) that runs on the ATCF, 9) A scripting language for generation of ATCF graphic files and 10) An automated dissemination of the warnings to Joint Metoc Viewer (JMV).

The next ATCF upgrade, ATCF 3.4, will focus on developing ways of integrating satellite imagery in the ATCF display and improving tropical cyclone data transfers between National Oceanographic and Atmospheric Administration and U.S Military forecast centers.

7.4 SSM/I TROPICAL CYCLONE STRUCTURE AND INTENSITY

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The Special Sensor Microwave/Imager (SSM/I) has a suite of passive microwave channels that enable it to penetrate non-raining clouds and map out tropical cyclone (TC) associated rain and moisture structure. This ability to detect rainbands, eyewall(s) and eye/center locations can significantly assist the analyst and Typhoon Duty Officer (TDO) when upper-level clouds obscure geostationary and/or polar orbiter visible and infrared (vis/IR) imagery. TC structure valuable for positioning and understanding storm intensity and intensity trends can then be used to upgrade the confidence and accuracy of storm warnings/advisories.

The Naval Research Laboratory's Marine Meteorology Division in Monterey, CA (NRL-MRY) has been exploring ways to extract additional information from the wealth of information contained in TC SSM/I imagery (Hawkins, et. al., 1998a, b). The main focus has been aimed at the high resolution (12-15 km) 85 GHz channels that nicely map TC structure and readily depict storm rainbands, eyewall(s) and center locations. This has been done by processing over 2,300 SSM/I passes coincident with TCs ranging in strength from tropical disturbances to super typhoons and CAT 5 hurricanes.

Numerous instances occurred during the 1998 season when SSM/I imagery was used to accurately view storm structure when not possible with vis/IR imagery. JTWC warning discussions now routinely mention passive microwave data when this valuable data set is incorporated as part of the satellite reconnaissance mission. During the end of the 1998 season, passive microwave data from the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI) began being posted by NRL-MRY for storms within the JTWC domain. The TMI is very similar to the more familiar SSM/I sensor, but has more than twice the spatial resolution since it is flying at half the SSM/I's altitude. Therefore, the 5-km 85 GHz images from the TMI can resolve features in tropical cyclones not previously seen with SSM/I data (Hawkins, et. al., 1999). Near real-time examples of both data sets can be seen on the NRL-MRY tropical cyclone web page: http://www.nrlmry.navy.mil/sat_products.html.

Two efforts have been studied to extract TC intensities from automated analyses of SSM/I digital data. The first effort involves a neural network method which; 1) uses 85 GHz, H-polarization brightness temperatures, 2) represents the patterns in the 85 GHz images via its Empirical Orthogonal Functions (EOF), 3) trains the neural net with the EOFs most highly correlated with intensity, and 4) trains the net with a dependent storm data base using JTWC/NHC best track intensities. The database now contains ¿ 1,100 TCs in the dependent data set and verification using "independent". Application to "independent" data sets such as for Super Typhoon Keith indicate the method has skill in matching the best track intensity trends, though has difficulty with rapid intensification. Techniques for using the intensity from previous images (similar to the Dvorak method) are undergoing tests.

The second effort utilizes computer vision capabilities to analyze both 85 GHz and rainrate products from the SSM/I. Spectral, spatial and textural measures were developed to extract features that are most highly correlated with TC intensity. Some of these features are analogous to those used within the Dvorak method, such as banding of particular temperature ranges, minimum brightness temperature, rainrates above a certain threshold, etc. Results to date indicate an RMS nearing 15 m/s, the likely accuracy of the best track data set. Evaluation of this method on Keith indicates significant skill in not only catching the intensity trends, but also in mirroring the best track fluctuations during the long-lived course of this storm's lifespan. Both methods are currently being retrained on a larger data set and will undergo a demonstration phase during the 1999 season.